UNIVERSITY OF CALIFORNIA
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
BERKELEY, CALIFORNIA

Olive Thinning and Other Means of Increasing Size of Olives

HARRY E. DROBISH

BULLETIN 490

April, 1930

UNIVERSITY OF CALIFORNIA PRINTING OFFICE
BERKELEY, CALIFORNIA
1930

OLIVE THINNING AND OTHER MEANS OF INCREASING SIZE OF OLIVES

HARRY E. DROBISH[1]

The first commercial olive orchards in California were planted because of the profits to be made from olive oil. The size of the fruit itself was not an important factor in determining the crop value since this was reckoned solely in gallons of oil produced, and one ton of small olives would yield about as much oil as one ton of large olives. A few years later, however, the price paid for oil olives dropped materially, with the result that olive growing became unprofitable and many orchards were neglected.

It was during this period that Mrs. Freda Ehmann of Oakland, California, experimenting in her home and aided by suggestions from the College of Agriculture of the University of California,[2] used a method from which the present process of pickling ripe olives developed. By personally introducing her product in the eastern markets, she started the commercial ripe-olive business and thus created a demand for pickle olives. Mrs. Ehmann sold her first olives in bulk. Subsequently, Professor F. T. Bioletti of the Division of Viticulture discovered that pickled olives could be successfully canned, and that aeration during the lye treatment darkened the olives. These facts were of importance in the development of the California pickled ripe-olive industry.

As the industry has developed, the size of the fruit has come to be a most important factor. Size of fruit, more than tonnage, now determines the return per acre. A small or medium crop of large olives brings better returns to the grower than a large crop of small fruit.

Olives less than $\frac{9}{16}$ of an inch in diameter are classed as oil olives and return a price to the grower very little above the costs of harvesting and delivering. Olives $\frac{9}{16}$ of an inch in diameter and larger have been until recently usually classed as pickle olives and are graded

---

[1] Formerly Specialist in Agricultural Extension and Farm Advisor of Butte County.

[2] Dr. E. W. Hilgard and Professor Paparelli contributed suggestions from information obtained in France and Italy.

according to size, each advance in grade representing an increase of 1/16 of an inch. The classes are given herewith:

DIAMETER	GRADE NAME	DIAMETER	GRADE NAME
9/16 inch	No. 9, or Small[3]	13/16 inch	No. 13, or Mammoth
10/16 inch	No. 10, or Medium	14/16 inch	No. 14, or Giant
11/16 inch	No. 11, or Large	15/16 inch	No. 15, or Jumbo
12/16 inch	No. 12, or Extra Large	16/16 inch	No. 16, or Colossal

Each grade higher brings an increase in price ranging from $30.00 to $75.00 per ton. There is probably no fruit grown whose value is enhanced as much per pound per unit of increase in size as is that of the ripe olive. For example, the market price in 1927 for pickle fruit of the Mission variety was $75.00 more per ton for the Mammoth than for the Extra Large size, although it is only 1/16 of an inch larger in diameter. It is greatly to the grower's benefit, therefore, to produce a higher percentage of large fruit.

It so happens that the Mission and Manzanillo are the varieties most extensively planted in California. Also, these two varieties make high quality pickles. But in years of heavy yield they do not produce a high percentage of the larger sizes. Obviously, then, any method of increasing the size of these better pickle olives would be a boon to the olive industry of California.

Primarily for the purpose of discovering such a method, the Agricultural Extension Service in Butte County first projected some tests with Mission olives in 1923. However, as the work progressed, it became apparent that the solution of this immediate problem of how to secure larger fruit was linked with the solution of three other important and unsolved problems in the growing of ripe olives for pickles, namely: (1) how to bring about early ripening; (2) how to reduce the loss from shriveling; (3) how to overcome the habit of alternate bearing.

PRELIMINARY OBSERVATIONS

Fertilizer Tests.—The work with olives undertaken in Butte County began with fertilizer tests to determine "the effect of fertilizer on the time of ripening, size of the fruit, set of fruit, and the length of the season's twig growth."[4] Two widely separated tests were conducted, each consisting of several plots, to each of which one of the following fertilizers was applied annually for three years: super-

[3] The size known as small, 9/16 inch diameter, has been dropped by the California Olive Association recently and at present practically all olives of this diameter and smaller are used for oil only and not for pickling.

[4] State Leader Project No. 1899, approved December 11, 1923.

phosphate, potassium sulfate, nitrate of soda, sulfur, gypsum, lime, and manure. Unfertilized plots with guard rows were left between the fertilized plots as checks.

The results observed in these fertilized plots in general were not reliable. In case of one of the tests an error was made one year in applying the fertilizer and in the other test it was discovered that the subsoil was not uniform, causing more variation in results than did the fertilizers applied. However, the trees fertilized with nitrate of soda, at the rate of 300 pounds per acre, in the test located on the Walter Haber ranch in the foothills near Wyandotte, produced results worth noting. The first year the nitrate was applied the trees produced an unusually large twig growth, followed the next year by an abnormally heavy set of fruit which did not color until after heavy frosts when the season had passed for harvesting for pickling. The trees bore no fruit the year following the big crop. The excessively heavy set was probably responsible for the other effects. These fertilizer tests failed to contribute any help in solving the chief problems of the olive industry unless they indicate that there is some value in the use of nitrate of soda in promoting setting of the fruit. Lighter applications of less quickly available nitrogen might have given a more moderate set with more favorable results.

But while the plots in this test were being studied, two valuable observations were made. There seemed to be a correlation not only between the number of fruits per tree and their size, but also between the number of fruits per tree and the time of ripening. The olive is generally recognized by commercial canners to be ready for processing for the preparation of ripe pickled olives after it has changed from the grass-green color to the straw green, with some fruit showing red. It is at this stage that the olive is considered to be 'ripe.' The trees bearing a small or medium crop produced large, early-ripening olives. The trees bearing an abnormally heavy crop were invariably late in ripening and the fruit remained comparatively small. The possibility of thinning to reduce an overloaded condition, to increase size, and to hasten ripening, suggested itself as worthy of trial.

Thinning by Summer Pruning.—Tests to determine the value of thinning by summer pruning as a means of increasing size were planned in cooperation with Professor Bioletti of the Division of Viticulture. One test was located in the Wyandotte district; another in the vicinity of Palermo. Overloaded trees were pruned in June, 1925, to reduce the number of olives on the tree. In some cases the entire tree was pruned sufficiently to remove about 50 per cent of the crop.

In others, only certain limbs were heavily pruned. Before the fall harvest, observations were made to discover any possible results from this summer pruning. No increase in size and no lessening of the time required for ripening was apparent.

Tests on Hand Thinning and Observations on Size and Time of Ripening, 1925.—Hand thinning of olives had been practiced in California before 1925 to some extent with the large-fruited varieties, such as Sevillano and Ascolano. Most of the growers have considered the hand thinning of Mission and Manzanillo olives to be highly impracticable, however, and reports from a few growers who have tried removing a portion of the fruit from one or two trees have given conflicting results. Before these studies were made no carefully controlled experimental work in olive thinning appears to have been carried on.

The first tests were planned with a three-fold purpose: (1) to find out if thinning would increase the size of the fruit; (2) to determine whether or not the increased returns due to greater size would more than pay the costs of thinning; (3) to determine how heavily it is advisable to thin in order to secure the greatest increased returns.

The first olive-thinning test was located in the 12-year-old Van Duzer orchard in Wyandotte. Most of this orchard had been manured heavily for several preceding years and it had set a heavy crop of fruit in 1925. More than half of the fruit (from 50 to 75 per cent) was removed from several overloaded trees. Adjacent overloaded trees were left unthinned as a check. This thinning was done on June 18.

About 2 weeks later it was decided to enlarge the test and thin additional trees much more heavily, lest by failure to remove enough of the crop, possible benefits should not be ascertained. The plan adopted for this heavy thinning was to leave a given number of olives per foot of twig. Little effort was made to space the olives on the twigs, the attempt being to establish a definite relationship between the total length of twigs on the fruiting branch and the number of olives left on that branch. To illustrate: a small branch consisting of two main twigs each 3 feet long with several smaller fruiting twigs, aggregating 5 feet in length, would have a total twig length of 11 feet. If the purpose was to leave 3 olives per foot of twig, such a branch would be allowed to retain 33 olives. For this heavier thinning, 3 additional overloaded trees were selected in the Van Duzer orchard and 3 others at the Berkeley Olive Association orchards 7 miles northwest of Oroville. Other overloaded trees nearby were marked to serve as checks. Only overloaded trees were chosen, since no benefit was expected from thinning trees carrying a normal crop.

The thinning in both of these tests was done between July 1 and 4. When completed, one tree in each test retained 3 olives per foot of twig, another 2 olives per foot of twig, and the third 1 olive per foot of twig. The thinning of this third tree was considered extremely heavy. By count, 24,000 olives were removed from the heaviest thinned tree in the Van Duzer orchard.

Figure 1 pictures an overloaded branch, a twig thinned to leave 1 olive per foot of twig, and a twig thinned to leave 3 olives per foot of twig.

Fig. 1.—Left, overloaded olive branch; center, branch thinned to one olive per foot of twig; right, branch thinned to three olives per foot of twig. July 2, 1928.

On October 17, the following observations were made on these several tests. The fruit on the first trees thinned, where the object was to remove 50 to 75 per cent of the crop, showed a slight increase in size as compared with the olives on the unthinned trees, but the increase was insufficient to be of any significance.

The heavily thinned trees on which only 1, 2, and 3 olives per foot of twig had been left, gave the most interesting results. The fruit on these trees was estimated to be, on the average, two sizes larger than the fruit on the adjacent trees. Although the fruit on the trees thinned to leave 1 fruit per foot of twig was larger than that on the trees where 2 and 3 olives per foot were left, the difference in size apparently did not justify the added work and the probable loss from decreased yield.

The fruit on these heavily thinned trees was ready to be picked at this time, being partly red and some even black in color, whereas the fruit on the unthinned trees was grass green in color and showed no indication of ripening very soon.

Thinning olives on a large scale was given its first trial the same year, 1925, by A. L. Chaffin, Superintendent of the Berkeley Olive

Association. A uniform block of 16 acres of 10-year-old trees was thinned by removing 50 per cent of the fruit from the overloads only. Thirty per cent of the trees were overloaded, and the thinning was done at a cost of $3.00 per acre. The balance of the same orchard, consisting of an equally uniform block of 10 acres, was left unthinned and served as a check. The two parts of the orchard were harvested separately and sold on size grade. The grade records from the packing plant showed that thinning had resulted in slightly increasing the size of the olives. The actual net increase in value for the pickle fruit amounted to only $10.18 per acre above the cost of thinning.[5] The fact that this light thinning gave some increase in size of fruit indicated that better results might be secured on a commercial scale by heavier thinning.

These preliminary tests furnished substantial evidence: (1) that Mission olives can be materially increased in size by thinning; (2) that to realize the maximum benefits from thinning an overloaded tree, more than 50 per cent of the olives must be removed; and (3) that fruit on thinned trees will color two or three weeks earlier than that on unthinned overloaded trees.

Observations of the Effect of Thinning on Alternate Bearing, 1926.—In 1925, the year of the first thinning tests, olive production in the Oroville district was heavy. Consequently in 1926 crops were light. This was as expected, for the olive has always shown a tendency to alternate bearing. Two characteristics of the tree explain this alternative bearing habit; first, olive fruits are produced almost entirely on new wood of the previous year's growth; second, the normal tree under average conditions does not produce much new twig growth during a season in which it matures a very heavy crop.

Therefore it is especially interesting to note that the three trees most heavily thinned in each of the tests in 1925 had a good crop of olives in 1926, that the fruit matured early and attained pickle size. The check trees that were overloaded but not thinned in 1925 were absolutely without fruit in 1926. This was an indication that heavy thinning could overcome the age-old tendency of the olive tree to bear only in alternate years.

The trees thinned in the orchard-size test at the Berkeley Olive Association showed somewhat similar results. In the block not thinned, trees overloaded in 1925 set no fruit in 1926, and the crop varied greatly on different trees. In the thinned block where there were no overloads in 1925 the crop in 1926 was much more uniform.

[5] Based on the Scale of prices given in the footnote of table 3, p. 15.

Alternate bearing has long been attributed partly to late harvesting. Late harvesting of the olives to be used for oil is customary, because olives, when allowed to hang on the tree until January, ripen fully, develop the maximum oil content, and are then worth several dollars more per ton for oil purposes than if harvested early in the season. Agricultural writers since ancient times have warned against this practice of late harvesting and condemned it as injurious to the next year's crop.

In the test located on the Van Duzer place, Wyandotte, all fruit of the 1925 crop on the thinned trees, as well as the overloaded trees, was left unharvested until January. In the following season, 1926, those trees not thinned ran true to form and set no fruit. But the trees which had been thinned heavily the previous season set a good crop despite the late harvest.

This experience indicates that possibly an overloaded condition in the previous season more than the late harvesting, is the principal cause of little or no crop in the following year.

It seemed advisable to investigate further the causes contributing to light crops. Therefore in the fall of 1926 a test was located in which 3 overloaded trees were picked and stripped at the normal time in November while 3 other overloaded trees were left untouched to wait for the January harvest. The following summer all the trees set a light crop of fruit, no apparent difference existing between the trees picked early and those picked late. These results supplied further evidence that the time of harvesting has little or no effect on the set of the crop the following year.

EXPERIMENT OF 1927

The value of hand thinning had been demonstrated in the tests conducted prior to 1927, as above noted. In at least six tests located in as many Butte County orchards, the thinning of Mission olives had proved to be beneficial. These tests were carried on in cooperation with local growers, and unfortunately in most instances complete data, including separate yield and grade records for each tree, were not obtainable.

In order to confirm results already secured, a uniform plot of trees was chosen, and an experiment planned in which separate yield and grade records would be kept for each tree. In the fall of 1927, Professor F. T. Bioletti helped to select the location of the experiment and outlined the procedure for obtaining the necessary data.

Plan of the Experiment.—The plot chosen was in Mr. G. J. Young's orchard, one of the Berkeley Olive Association plantings. This was a 16.7-acre orchard of 13-year-old Mission olive trees, which were about 12 feet in height and with an average spread of 12 feet. They had been pruned very little since the third year after planting, and the branches drooped to the ground. (Note figs. 2, 3, 4, and 5.)

Two blocks, totaling 11.0 acres, were chosen for thinning. The balance of the orchard, 5.7 acres, was left untouched. The thinned block consisted of rows of 1–10 inclusive and rows 19–27 inclusive; rows 11–18 were unthinned. It will be noted that the check block was in the center of the orchard, between the two thinned blocks.

Thinning was done in the last week of June, 1927. All olives where 5 or more could be removed with one grab of the hand were stripped off the overloaded trees. Spacing was disregarded, the object being to do the work quickly and inexpensively; this was necessary from the practical point of view; however, the fruit was left on at the rate of about 2 or 3 olives per foot of twig. The heavier thinning was done on the north and west sides and on the lower limbs of the trees, so that more fruit remained on the upper branches and on the sunny east and south sides. No count was made of the overloaded trees before thinning, but a count of all trees in the unthinned part of the orchard, which was representative of the whole, showed that 59 per cent of the trees were overloaded and 41 per cent bore a normal crop or less. The fruit from the thinned and unthinned blocks was picked, weighed, and graded separately.

In this orchard, two adjacent rows, Nos. 10 and 11, were selected for a small-scale individual tree-record experiment. No. 10 was the last row of one thinned block; No. 11, the first row of the unthinned. Twenty trees in each row were chosen for the experiment, but subsequently tree No. 30 (a small tree evidently a replant) in row No. 10 was eliminated from the records, making a total of 19 thinned trees and 20 unthinned trees to be tabulated. Of the 20 unthinned trees, 13 were overloaded; 7 bore normal crops or less, and did not need thinning (see table 1). However, the fruit from all 20 was added together in arriving at the total production of the unthinned trees in row 11 (see tables 1 and 2). The location of the trees included in the small-scale experiment was as follows:

Row 10 (thinned row): 19 thinned and normal-crop trees—Nos. 5–11, 18, 19, 24–29, and 31–34.

Row 11 (unthinned row): 13 overloaded trees—Nos. 5, 7–10, 12, 14, 23, 26, 28, and 30–32; and 7 trees with normal crop—Nos. 6, 11, 13, 24, 25, 27, and 29.

Fig. 2.—An overloaded olive tree in row 11, experiment of 1927. Note the branches drooping with the heavy load of fruit. Photographed October 18, 1927.

Fig. 3.—A thinned olive tree in row 10, experiment of 1927. Note the more upright-growing branches. Photographed October 18, 1927.

Fig. 4.—Unthinned row 11, experiment of 1927. Note the overloaded trees and drooping branches. Photographed October 18, 1927.

Fig. 5.—Thinned row 10, experiment of 1928. Note the upright-growing branches. Photographed October 18, 1927.

TABLE 1

AVERAGE YIELD FROM THINNED AND UNTHINNED TREES IN SMALL-SCALE EXPERIMENT, G. J. YOUNG ORCHARD, 1927

Size	Thinned trees, row 10, 19 trees	Unthinned trees, row 11		
		13 overloaded trees	7 normal-crop trees	Average, 20 unthinned trees
	pounds per tree	*pounds per tree*	*pounds per tree*	*pounds per tree*
Oil fruit*	14.38	96.55	11.14	66.67
No. 10's	4.15	8.04	4.48	6.79
No. 11's	16.18	11.71	16.73	13.47
No. 12's	42.65	9.63	30.47	16.92
No. 13's	10.06	1.15	8.87	3.85
Total yield	87.42	127.08	71.69	107.70
Total yield, pickle olives	73.04	30.53	60.55	41.03

* Olives smaller than 10/16 inches in diameter were not used for pickles in 1927 and are therefore classed as oil olives. Oil fruit in this table includes all olives that were not harvested until after the frost, regardless of size.

TABLE 2

AVERAGE YIELD FROM THINNED AND UNTHINNED TREES IN SMALL-SCALE EXPERIMENT, COMPUTED ON AN ACREAGE BASIS, G. J. YOUNG ORCHARD, 1927

Row	Plot	Pickle pick		Oil pick		Total yield	Total value	Total cost of harvest and thinning	Net return	Net gain on thinned trees	
		Yield	Cost of harvest	Yield	Cost of harvest					Above unthinned trees*	Above unthinned overloaded trees
		pounds	*dollars*	*pounds*	*dollars*	*pounds*	*dollars*	*dollars*	*dollars*	*dollars*	*dollars*
10	Thinned trees	4,747.1	66.58	839.7	9.24	5,596.8	355.20	89.82	265.38	97.91	119.48
11	Unthinned trees*	2,811.5	39.34	4,081.9	44.90	6,893.4	251.71	84.24	167.47	......	......
11	Unthinned overloaded trees	2,201.6	30.80	5,932.8	54.34	8,134.4	231.04	85.14	145.90	......	......

* Includes 13 overloaded trees and 7 with normal crop.

During each of the two pickings, the fruit from each tree was handled separately in boxes marked with the tree numbers. The olives from each tree were then graded and weighed. Sizes above No. 13 could not be separated by the hand grader which was used. Consequently all No. 14's and larger had to be reckoned as No. 13's. There were many of these larger olives, and if their exact grades and corresponding values could have been determined, the total value of the fruit from the thinned trees would have been greater.

The Results—

1. *Increased size.* As in the previous tests, marked increase in size was observed. Table 1 gives the average yields of the thinned and the unthinned trees. In addition, it gives the average yields, computed separately, of the 13 overloaded trees in the unthinned row and of the 7 trees in that row which bore a normal crop that season. The table shows that in the pickle sizes there were nine times as many pounds of No. 13's and four and a half times as many No. 12's from the average thinned tree as from the average overloaded, unthinned tree. A comparison of the figures indicates an increase of 140 per cent in yield of olives salable for pickles. The record of the 7 trees bearing a normal crop or less in the unthinned row compares favorably with the record of the thinned trees. Because some of these 7 trees actually had less than a normal crop, their average yield is a little less than that of the thinned trees.

Table 2 shows the results of this experiment when calculated on an acreage basis, using 64 trees to the acre.[6] In this case thinning actually reduced the total yield 1296 pounds per acre, but increased the net profits $97.91 per acre. If the normal-crop trees in the unthinned row are omitted, and a comparison is made with the overloaded trees alone, it will be seen that the trees in the thinned row yielded at the rate of 2537 pounds less per acre, but that the net return was $119.48 more.

Table 3 records the yields, in the large-scale test, for both the years 1927 and 1928 from the entire Young orchard, more than half of which had been thinned in 1927. In 1927 olives of pickle grade comprised 74.1 per cent of the thinned crop, but only 32.9 per cent of the unthinned. Moreover, the records indicate that in this test, thinning did not result in materially decreasing the total weight per acre of the crop harvested. The actual cost of thinning in this case was $14.00 per acre. Deducting this cost, the gain in favor of thinning in this orchard amounted to $64.33 per acre in 1927. The 1928 yield record is discussed under the head of "Further Observations of the Effect of Thinning on Alternate Bearing," page 17.

It will be noted that the profit per acre due to thinning in the orchard as a whole is smaller than that in the small-scale plot. This is probably owing to the difference in the proportion of overloaded trees and to the fact that the size and vigor of many trees in the orchard were lower than those in the small-scale plot.

Table 4 shows the increase in size resulting from thinning for the entire crop from the trees in the 1927 experiment, including both

[6] There were 64 trees to the acre in this orchard.

pickle pick and oil pick. The olives harvested after the frost were also graded and in this table included with the records of the pickle pick. The average or mean yield per tree, the probable error, the standard deviation, and the coefficient of variation were greatest in the unthinned trees except in the No. 10's and smaller sizes. Pickle sizes on the thinned trees amounted to 97.9 per cent of the crop, on the unthinned overloaded trees, to 67.4 per cent of the crop. The average total weight of the pickle sizes is nearly the same for each block. The great difference is due to the increase in yield of the valuable sizes, No. 12 and No. 13, from the thinned trees. This is graphically shown by figure 6.

TABLE 3

Effect of One Thinning on Yields and Returns* per Acre for the Current Year and the Year Following; Large-Scale Test (16.7 Acres), G. J. Young Orchard, 1927 and 1928

Year	Treatment	Acres	Pickle pick		Oil pick		Total fruit	Total value	Cost of harvesting and thinning	Net return	Net gain above unthinned block
			Pounds	Per cent	Pounds	Per cent					
							pounds	*dollars*	*dollars*	*dollars*	*dollars*
1927	Unthinned	5.7	1,650.0	32.95	3,359.9	67.05	5,009.9	165.08	60.05	105.03	....
	Thinned	11.0	3,680.6	74.10	1,287.9	25.9	4,968.5	249.06	79.70	169.36	64.33
1928	Unthinned	5.7	1,077.3	36.79	1,851.8	63.21	2,929.1	97.02	35.45	61.57	....
	Unthinned†	11.0	1,773.7	31.12	3,926.0	68.88	5,699.7	172.42	68.02	104.40	42.83

* Based on following valuations and costs:

No. 13's	$225.00 per ton	Oil	$40.00 per ton
No. 12's	150.00 per ton	Thinning cost	14.00 per acre
No. 11's	100.00 per ton	Harvesting and hauling oil olives	22.00 per ton
No. 10's	70.00 per ton	Harvesting and hauling pickle olives	28.00 per ton

† Thinned in 1927.

TABLE 4

Average Tree Yield, Standard Deviation, and Coefficient of Variation in Pounds per Tree, in Thinned and Unthinned Rows, G. J. Young Orchard, 1927. (Time of Picking Disregarded)

Size	Thinned row—19 trees			Unthinned row—13 overloaded trees		
	Mean	Standard deviation	Coefficient of variation	Mean	Standard deviation	Coefficient of variation
Total crop	87.4±4.2	27.3±3.0	0.32±0.04	127.2±6.8	43.1±5.7	0.34±0.04
Total pickles	85.5±4.0	26.1±2.9	.31± .03	85.8±8.2	43.1±5.7	0.50± .07
No. 13	10.5±1.0	6.3±0.7	.61± .07	1.2±0.3	1.4±0.2	1.18± .16
No. 12	46.8±2.0	12.9±1.4	.28± .03	13.9±2.8	15.0±2.0	1.08± .14
No. 11	21.2±1.6	10.6±1.2	.50± .06	29.1±4.0	21.1±2.8	0.73± .10
No. 10	7.1±0.8	5.1±0.6	.72± .08	41.7±3.6	19.1±2.5	0.46± .06
Smaller than No. 10	1.9±0.4	1.8±0.2	.97±0.11	41.4±4.0	21.1±2.8	0.51±0.07

2. *Earlier ripening.* The first or pickle pick occurred in the orchard where the experiment was located, between November 22 and 27. At that time most of the fruit on the thinned trees was of good size and was well colored; but only a part of the olives on the unthinned overloaded trees was ready for picking. By referring to table 2 it will be seen that over twice as much pickle fruit was harvested at this time from the thinned trees as from the unthinned overloaded trees. As in the preliminary test, this experiment had again shown the value of thinning in hastening the time of ripening.

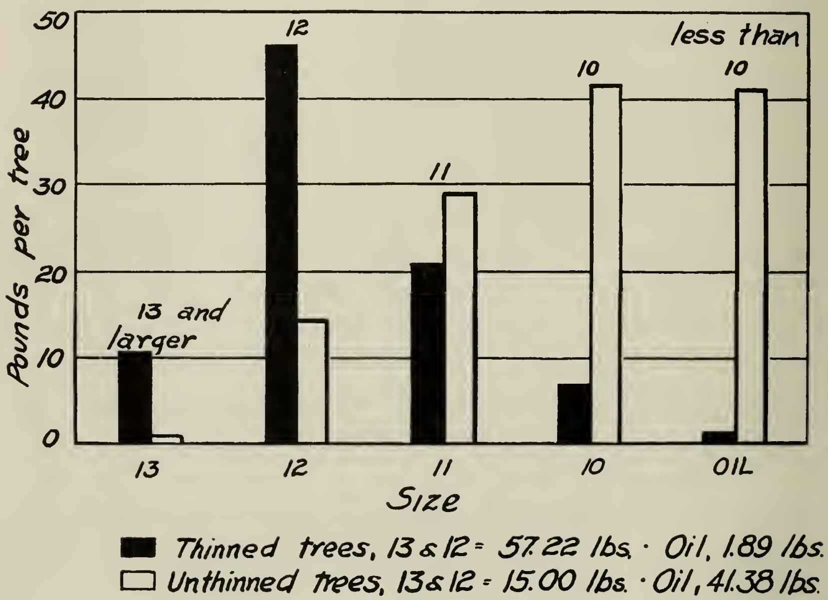

Fig. 6.—Effect of thinning on the crop of olives; oil pick included.

3. *Decrease in shriveling.* Earliness of ripening is a very desirable characteristic, especially in years when the olive crop in general matures late. In orchards exposed to early frost, the fruit must mature early if it is to be sold for pickles, for frost damages the olives and causes them to shrivel. Even if the temperature is a little above freezing, immature olives are still in danger of shriveling if they are exposed to drying winds. Much shriveling renders the fruit unfit for pickles.

A week after the pickle pick, frost occurred in the orchard where the experiment was located. On 9 of the 13 overloaded trees, the remaining fruit was shriveled by this frost; only 1 of the thinned trees

suffered any shriveling of its olives, and they were reported as only slightly shriveled.

It has frequently been observed in the Oroville district that fruit on overloaded trees is more subject to frost damage and shriveling than that on trees bearing a light or normal crop. Possibly the overload is so great a drain on the tree that it lessens the resistance to frost and to the damaging effect of cold dry winds. Again, it appears that green fruit is more subject to frost damage and shriveling than is riper fruit with a higher oil content. In either case, these observations indicate that thinning, by reducing the overload and thereby hastening the time of ripening, will cut down the loss from shriveling.

Limitations.—The thinning work carried on thus far has been with trees of the Mission variety all in the Oroville district. Similar results might naturally be expected with other varieties and in other parts of the state.

All experimental thinning has been with trees 14 years old or less. Few large, old trees have been thinned. With very large trees, obviously, the task would be more difficult. But since old trees are less inclined to overbear and their fruit is generally larger than that of younger and smaller trees, thinning would be less needed.

FURTHER OBSERVATIONS OF THE EFFECT OF THINNING ON ALTERNATE BEARING

On July 9, 1928, one year after the trees in the experiment had been thinned, the crop condition on each of the 39 trees was noted. The trees in the unthinned row which bore an overload of fruit in 1927 set a very light crop in 1928. All trees which matured a moderate crop in 1927, whether normal or secured by thinning, set a fair or good crop in 1928. Separate yield data and grade records were not secured for 1928 from the trees included in the 1927 experiment.

Separate yield records were kept for the thinned and for the unthinned parts of the entire 16.7-acre orchard for the year 1928, and are shown in table 3. This table sets forth clearly, not only the effect of thinning on the crop of the same year, but also on the crop of the following year. The parts of the orchard thinned in 1927 produced a very good crop of olives in 1928. The part not thinned in 1927 produced a short crop in 1928. The thinning in 1927 resulted in a profit the same year of $64.33. In 1928 no thinning was done in this orchard, but the part which had been thinned in 1927 gave an increased profit of $42.83 per acre over the part not thinned in 1927.

Therefore, the net profit for the one thinning operation, figured over a 2-year period, totaled $107.16.

This same summer, 1928, other thinning tests in the vicinity of Oroville, besides the large-scale test in the entire Young orchard where the experiment was located, gave in general the same results as those observed in the experimental rows. All these results, evidenced in the 1928 crop set, confirmed the observations made in the preliminary tests and emphasized the value of thinning in overcoming the habit of alternate bearing.

It is fully as important to establish regular bearing in an olive tree as to increase the size of the fruit. If these two ends can be accomplished with one operation, thinning, then the cost of one thinning can be charged to two years' operation, cutting in half the first charge for thinning.

GENERAL RECOMMENDATIONS

The Time to Thin.—The general time rule for thinning fruits, namely, to remove them before the seed hardens, seems to hold with the olive. Season and location will influence the date for thinning, but generally it should be done in the period between June 15 and July 15. Possible benefits from later thinning have not been determined, but in one orchard where thinning took place after the seed hardened, no increase in size resulted.

Methods of Thinning.—Because of the enormous number of fruits to be removed, olive thinning will be impractical unless the work can be done economically. The following suggestions have been tried and have proved valuable aids.

1. Tape the fingers for protection before undertaking a big job of thinning. Adhesive or tire tape may be used.

2. Thin only those twigs where at least 5 olives can be removed at one pull.

3. Use both hands, stripping the olives from several twigs at once with one combing by the fingers.

4. In general do not attempt to space the olives on the twigs.

5. Leave, on the branches thinned, an average of 2 or 3 olives per foot of twig.

6. Remove more olives from lower and shaded portions of the tree; fewer from the open tops and those parts receiving the most sunlight.

7. The tendency is to leave too many fruits on the tree. Practice is necessary before efficiency and maximum benefits will be realized.

8. In any first attempts at thinning olives, it is advisable to leave overloaded, unthinned trees near the thinned trees to serve as checks for measuring the value of the resulting increase.

Preliminary Pruning.—The task of thinning will be greatly lessened if the trees that have a dense growth are opened up the preceding winter by pruning. This pruning should consist of the removal of whole branches, secondary branches, and dense twig clusters to open up the tree to sunlight. In an orchard with a habit of bearing heavy crops in alternate years it would appear that the proper time to prune, not only to open up the tree but to reduce the following set, would be after the light crop and not after the heavy crop, though the latter might be the natural tendency. In a year following a big crop the set tends to be light and the twig growth will be at the maximum. Winter pruning after this light yield, in addition to opening up the tree, will tend to reduce the fruiting twigs and consequently the number of olives that will be set on the tree the following spring.

COSTS OF THINNING

At first thought the expense of thinning overloaded olive trees may seem prohibitive; but the practical accomplishment of thinning has shown the contrary. Overloaded trees 12 feet high with a spread of 12 feet have been properly thinned for from 20 to 50 cents a tree, by unskilled labor paid 35 cents an hour. This amounted to about $14.00 per acre where 60 per cent of the trees were overloaded.

The cost will depend upon: (*a*) the size of the tree, (*b*) the amount of the overload, (*c*) the density of the twig growth, (*d*) the efficiency of the crew, (*e*) the number of overloaded trees per acre.

SUMMARY

1. The present demand is for pickle olives of large size.

2. Heavy applications of nitrate of soda increased the twig growth, resulting in a heavy set of olives the following year. The sizes were small, the ripening late, and in the next year the trees bore no fruit.

3. Summer pruning to increase size of fruit has shown no benefit.

4. Hand-thinning of the overloaded trees has achieved the following results:

a. Increased size of fruit.

b. Earlier ripening.

c. Decreased danger of loss from frost and from shriveling.

d. Reduced tendency to alternate bearing.

5. The cost of thinning is not prohibitive when compared with the increased value of the crop.

6. Thinning should take place before the seed hardens.

7. Olives are quickly thinned by stripping the twigs between taped fingers.

8. Overloaded trees should be thinned to 2 or 3 olives per foot of twig.

9. Late harvesting of the fruit does not appear to affect the set of olives the following year.

10. The benefits derived from thinning olives appear to be fully as great as from the thinning of other fruits, if not greater.

ACKNOWLEDGMENTS

The excellent cooperation of the Butte County olive growers, Butte County Extension Service Agents, and members of the Research Staff of the College of Agriculture has made possible the work in olive thinning described in the foregoing pages.

Among the growers, I am especially indebted to A. L. Chaffin, Superintendent of the Berkeley Olive Association, for his wholehearted cooperation in the entire undertaking, for his valuable observations, and his helpful suggestions on the technique of thinning.

W. B. Haber, V. Van Duzer, R. P. McCune, B. B. Meek, W. B. Hengy, and G. H. Firestine are other growers who have given valuable suggestions and generous cooperation.

Professor F. T. Bioletti has served in an advisory capacity from the beginning of the work, checked the data, and given assistance necessary for the satisfactory completion of the project. I. J. Condit of the College of Agriculture assisted actively in the early plans for the project.

Messrs. H. E. Paxton, B. L. Smith, and E. Torpen, assistant farm advisors, deserve credit for their part in carrying on the project. Mr. Torpen, especially, performed a valuable service in securing and tabulating the 1927 experimental data and in taking some of the photographs used in this bulletin.